Another promising area with significant growth opportunity is **virtual power plants** (VPPs), which are well suited for a future with a high concentration of **variable renewable generation** and **flexible customer loads**. VPPs may be another form or type of **platform** business that aggregates large numbers of buyers and sellers with flexible load and generation and allows them to efficiently transact as a group with each other or with the network operator, with the help of an enabling aggregator.

As is true for platform operators, VPPs need virtually no assets, have little risk exposure and virtually no labor costs while enabling customers with **flexible loads** to participate in markets with **variable renewable generation**.

To be successful in this space, as in the case of platforms, the VPP needs to gain massive scale to be profitable as a business. All platforms benefit from the so-called "**network effect**" – which means that the ones that attract more customers, more traffic and massive scale become more valuable, more useful, attract more users, and become more dominant, as in the case of **Facebook** or **Airbnb**. Once those entrants are successfully established, newcomers will have a tough time to challenge them. The network momentum gets harder to compete with as these entities grow in size.

Next Kraftwerke, a VPP company based in Cologne, Germany, for example, has over 4.5 GW of flexible load/generation under management from over 5,400 participants on its network. By sending signals to its participating members, it can save them money by lowering their energy costs while getting paid by the grid operator for providing much-needed capacity, ancillary services, flexibility, voltage support, and other tangible services.

Recently, **Next Kraftwerke,** one of Europe's earliest and largest VPPs, announced that it was adding **storage** to its portfolio of assets to offer enhanced frequency control in the **Belgian market**, one of the countries into which it has expanded beyond its German home base.

The company has teamed up with sustainable energy company **Eneco Belgium** and battery supplier **Alfen** to integrate a 2 MW battery, which is remotely monitored, into its portfolio. The battery provides **frequency control reserve** (FCR) to the Belgian grid operator.

According to **Paul Kreutzkamp**, co-founder and co-manager of Next Kraftwerke Belgium, the operator can constantly measure the grid's frequency, allowing the battery to counteract frequency deviations from 50 Hertz in real time. The response time of the battery is much faster and more accurate than any other technology delivering FCR to the grid. Similar claims have been made by **Tesla**, which has been operating a much larger 100 MW battery in South Australia since last year.

Next Kraftwerke also manages charging and discharging of the battery to maintain synchronous 200 mHz FCR product to the Belgian transmission system operator. The battery's charging strategy takes into account other assets in the portfolio and combines their flexibility with that of the battery to maximize availability and security of supply. Moreover, all assets in the portfolio are operated in such a way as to maximize the overall value of the portfolio.

In a later phase, the battery will be integrated with 2 wind turbines on-site. The battery will store the energy at times of excess wind generation, then discharge some of the stored energy for later use, thus increasing the customer's ability to self-consume and take advantage of price differentials at different times.

Clearly, many combinations of load, generation, and storage are beginning to emerge, including those that can power **fast-charging electric vehicle stations**, facilitate **energy trading**, offer **balancing** and **flexibility services**, and provide a clean alternative to diesel generators at outdoor festivals and events. ■

https://doi.org/10.1016/j.tej.2018.09.007

Report Reveals Who's Fighting Climate Change, And Who's Not

Are we making progress in addressing **climate change?** It all depends whether you're a glass-half-full or glass-half-empty kind of person. The good news is that in some places significant progress has been made, is being made, or can be expected. Against this backdrop, though, is the continued rise in global energy demand – still mostly supplied by fossil fuels – that appears to neutralize the progress being made elsewhere to reduce emissions. The bottom line is that the atmospheric concentration of CO_2 has risen from 315 parts per million in 1958 to 400 ppm today as measured at the **Mauna Loa Observatory** in Hawaii. The 350-ppm target is history. We now have to worry about reaching 450 ppm levels and higher.

Those looking for good news can find cheering anecdotes, sometimes from unexpected places. For example, **Scotland** reports that its 2016 greenhouse gas (GHG) emissions were *down* by 49% from1990 levels. Likewise, the **UK**'s emissions were *down* 43% compared to the 1990 baseline, even as the economy has grown significantly over that period. The progress in this case is largely attributed to decarbonization of the power and waste sectors, with little progress in buildings and increases in the transportation sector. Unless these trends are reversed, the UK is unlikely to meet its future carbon budget.

To get a sense of who is leading or lagging in the fight against climate change, a recent **United Nations** publication on **Sustainable Development Goals** (SDGs) provides some clues.

Climate action, by the way, is #13 on a list of 17 goals set up by the UNPD. It is an ambitious program to essentially solve all the world's unsolvable ills, including poverty, hunger, health care, education, gender equality, clean water, affordable clean energy – and all the way down at #13, climate action – or the lack thereof. Among issues missing from the UN's list are world peace, ignorance, arrogance, and greed.

The latest **SDG Index** released in July 2018 shows how some countries are doing a better job than others. Overall, the best-performing countries are the northern European nations of **Sweden, Denmark, Finland**, **Germany**, and **France** – in that order – all of them with a history of balancing economic, social, and environmental priorities.

The top 14 countries are in Europe, with **Japan** as #15. The **US** is ranked #35, **Australia** #37, **Mexico** #84, **South Africa** #107, the **Central African Republic** #156. The countries with lower rankings are not doing well.

A few stand out like a sore thumb. **Australia's** annual CO_2 emissions, for example, are reported at an incredible 44 tonnes per person, exceeding those of the biggest oil-exporting country, **Saudi Arabia**, at 35.5 tonnes per person – both orders of magnitude bigger than the not-so-green U.S. at 710 kg per person. The explanation is simple. Once you include the so-called "spillover effects" – which include positives, such as providing development aid, or negatives, such as exporting huge quantities of polluting products like coal or oil – Australia and Saudi Arabia sink to the bottom of the rankings.

Saudi Arabia apparently is not particularly concerned. Some Australians, but not their current federal government, apparently are. Australia not only uses a lot of coal and other fossil fuels but exports huge quantities to be burned elsewhere and is penalized for this in the UNPD's rankings. Ditto Saudi Arabia, where the bulk of the oil production is currently exported.

When it comes to **intended nationally determined contributions** (INDCs) – that is what governments have thus far voluntarily pledged to contribute to the goals of the **2015 Paris Climate Accord** – the track record is rather dismal among the G20 economies. Only **India** gets a reasonable rating among those top 20 global economies, while the **U.S.** is listed as "**critically insufficient**," the same rating as **Saudi Arabia. South Africa** is rated as merely "highly insufficient" – apparently defined to be less bad.

Under the **Trump Administration**, the U.S. has officially announced that it plans to withdraw from the global climate accord. Don't expect a turnaround in the U.S. rankings as long as President Trump remains in the White House. ■

https://doi.org/10.1016/j.tej.2018.09.008